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CONTROL OF THE NANTUCKET PINE TIP MOTH
IN THE CENTRAL STATES

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With the great increase in the planting of shortleaf and other native yellow pines in the Central States, the Nantucket pine tip moth, Rhyacionia frustrana Comst., is rapidly becoming one of the most important insect enemies of hard pine plantations in this region. This pest occurs naturally throughout the Central States wherever native yellow pines are found, but its distribution has been greatly extended and its depredations have been greatly increased in recent years, through the use of infested nursery stock.

In certain sections of southern Illinois, western Kentucky, and Tennessee the damage by this insect is so severe as to cause almost complete destruction of the plantations infested. The most serious injury in the Central States appears to occur in shortleaf and loblolly pines, although injury, oftentimes serious, has been observed in plantations of other yellow or hard pines, such as pitch, Norway, Virginia, jack, ponderosa, slash, Austrian, Scotch, Corsican, and Japanese red and black pines.

The reason for the more serious injury in the native southern pines (loblolly, shortleaf, Virginia, and pitch) appears to lie in the habit of growth of these species. All of these put on periodic seasonal growth (two and usually more whorls are produced annually) and produce adventitious buds below the point at which the twig is killed by the boring larvae. These two combined factors guarantee new buds and twigs for each generation of larvae and thereby make conditions most favorable for development of this insect.

An important aspect of this problem is that practically every seriously infested plantation in this region has unquestionably resulted from the planting of infested nursery stock. This also suggests a practical measure of prevention.

Preliminary studies of this insect conducted at the Central States Forest Experiment Station of the Forest Service at Columbus, Ohio, since 1931 indicate a high probability that much, if not all, of the planting stock was infested by tip moth eggs before it left the nursery. The records of practically all the seriously infested plantations in this region show that the stock was field planted from several weeks to two months after the time of emergence of the first brood of adults in the spring, which would allow ample time for eggs to be deposited on the stock in the nursery.

In 1935 a careful examination of the nurseries in this region which were suspected of distributing infested stock showed that every one had tip moth infestation in the yellow pine nursery beds.

From this it appears that the logical approach to this problem is the proper handling or treatment of nursery stock. It is strongly urged that all hard pine nursery stock raised in this region be treated in a manner which will make it reasonably certain that there will be no further distribution of the Nantucket pine tip moth on such material.

Control of infestations in plantations requires measures different from those proposed for nursery stock and will be discussed later.

Treatment of Planting Stock

Wherever the planting agencies are producing their own nursery stock in local nurseries, the following procedure is recommended:

1. Make a very careful inspection of all hard pine nursery beds in the fall to determine if tip moth infestation is present. Preferably this inspection should be made by a competent forest entomologist or by some one who is familiar with the symptoms of attack, which is usually indicated by the presence of dead buds, tips, or needles. Occasionally the only indication of attack is the presence of excess resin on the bud. At the same time an inspection should be made of any hard pines growing nearby to determine if infestation is present.

2. If any infestation is discovered in the nursery or in areas adjacent, carefully remove all infested tips or buds from the nursery stock, making sure that they are cut low enough to remove any larvae or pupae present. In this region the work should be done late in the fall after the last brood has reached maturity. If the nursery stock is to be fall planted, no further treatment appears to be necessary.

3. For stock which is held over for spring planting, it is strongly urged that it be given a dipping treatment, such as is recommended by Baumhofer in mimeographed circular E-366. An alternate method of handling such stock is to dig it in midwinter, after the infested buds have been removed, and heel it in under a fine-mesh wire screen (16 mesh) until it is ready to be shipped out for planting. This latter method should prevent any eggs from being deposited on the seedlings from the first generation of moths, which in the southern part of the region may be expected to emerge as early as February.

If the stock is heeled in under screens as suggested above, unusual care should be exercised at the time the trees are taken from the screened beds to guard against moths laying eggs on the stock at this time. Do not leave the stock exposed for any longer time than is necessary to remove it from the beds. If the stock is to be transported in open trucks for any distance, it would be advisable to cover it with canvas or screens so that it can not be infested en route. The above precaution applies also to stock which has received dipping treatment in the spring.

If it is necessary for planting agencies to obtain stock from nurseries over which they have no control, and particularly from nurseries located in the South, it is strongly recommended that Baumhofer's method of treatment be given to all hard pine stock before it is planted in order to kill any eggs which may be present. In addition, this stock should be carefully inspected, and if any infested tips are found, these should be removed as previously recommended.

Promising preliminary results have been obtained by Wm. Middleton and C. A. Weigel in the use of hydrocyanic acid gas as a fumigant for the control of the subspecies bushnelli in the pupal and larval stages. These tests were made in the laboratory under controlled temperature and humidity conditions and can hardly be applied in the field, but the results do suggest a promising approach for future field experiments in the control of R. frustrans in nursery stock during the fall or winter. If the suggestions of heeling in the stock under screens is followed, it would be a comparatively simple matter to run fumigating tests on these.

The use of shortleaf pine planting stock in the Central States has been so great during the past two years that the nurseries have not been able to supply the demand. For this reason, certain nurserymen in the southern part of the region have been filling part of their orders with field-dug seedlings. The danger of tip moth infestation in such material is very great, and it is particularly important that all wild stock be given a dipping treatment before planting, and be carefully examined for the removal of all infested tips which may contain larvae or pupae.

In the Central States it is recommended that all stock be treated even if it is to be planted in areas where known infestation occurs. The reason for this is that such stock, if free of infestation at the time of planting, stands a much better chance of survival during the first year than does infested stock.

Treatment of Infested Plantations

It is practically impossible to eradicate the tip moth, once it becomes established in a plantation. The removal of infested tips can be expected to give only partial control even in plantations where the trees are small. When they reach a height of over 6 feet, it becomes increasingly difficult to carry out this type of control. This method was tested about a year ago in a severely infested hard pine plantation in southern Illinois. This plantation was isolated from any other sources of infestation by over 40 miles, so that the tip moth was unquestionably brought in with the nursery stock. Although this treatment appears to have reduced greatly the number of larvae per tree, it has not as yet reduced the infestation to a satisfactory degree and has been very costly in effort and time.

In Nebraska, Burnhofer has reported some encouraging results from the introduction of parasites to control the midwestern pine tip moth, Rhyacionia frustrana bushnelli Busck, a close relative of the Nantucket pine tip moth. It appears that the introduction of parasites may be an effective weapon to use against the Nantucket pine tip moth. From the preliminary work done on this insect in the Central States, it is quite evident that hard pine plantations in the proximity of native yellow pine stands usually suffer relatively little damage from tip moth injury, owing to control by native parasites. On the other hand, where infested nursery stock has been planted a long distance from any native pine stands, the damage has been most severe, indicating an absence of parasites. The records of 25 plantations given in table 1 show this relationship clearly.

Table 1.--Data regarding Nantucket pine tip moth infestation and parasitization in 25 pine plantations

Number of plantations observed	Number of miles to nearest native pine		Degree of infestation	Average percentage of tip moths parasitized
	Range	Average		
8	25-100	30	Severe	3.5
5	5-25	9	Medium	15.0
12	0-5	2	Light	65.0

Life History

Complete life-history records of the Nantucket pine tip moth are lacking for various sections of the Central States. From general observations and a limited amount of rearing work done in 1933 and 1934, however, it appears that adult moths emerge in Tennessee, Kentucky, and southern Illinois during the latter part of February and in southern Ohio about a month later. Eggs are deposited on either the needles or bud scales, or on the twigs, and are very inconspicuous. The larvae upon hatching bore into the bud or twig and mine out the interior, causing death to the portion mined. In light attack the bud is usually the only portion of the tree killed, but in serious attack the entire current season's leader or lateral growth may be killed.

In plantations where the infestation is very severe certain trees may be killed, while those remaining are so badly deformed that the form of the tree is permanently affected so that these trees develop a "cabbage" appearance. Each twig which is injured puts out adventitious buds below the point of injury, several leaders usually being formed from the injured member, and the number of leaders being increased after subsequent attack. Shortleaf and loblolly pines over 15 feet in height have been observed in plantations where as many as ten leaders were developing, with each enjoying the same relative degree of dominance.

At maturity the larvae pupate within the bud or twig, from which the adults later emerge. In the southwestern part of the region there are at least three, and possibly four, generations of this insect annually, while in southern Ohio there appear to be but two generations. The last generation of the year usually passes the winter as pupae within the buds or tips, but occasionally larvae may be found during the winter months.

P. C. Wakeley^{1/} has carried on some important work on the habits and life history of the tip moth in Louisiana and has found by careful rearing work that there are definitely four generations annually of this insect in that State.

^{1/} Notes on the Life Cycle of the Nantucket tip moth. Occasional papers No. 45. Southern Forest Experiment Station, New Orleans, Louisiana, April 2, 1935.